METEO 469 PROBLEM SET #4

NAME:

DUE:

Modeling the Earth's Climate Using One-Layer Energy Balance Model

**1. *Worksheet successfully downloaded!***

**2. Using the on-line one layer EBM application, double the CO2 concentrations relative to the pre-industrial level and calculate the climate sensitivity and warming of the mid-troposphere for the following three cases:**

**(A) no feedbacks (i.e., cloud feedback, water vapor feedback, and ice feedback factors all set to zero);**

**(B) mid-range feedback factors (i.e., the default settings of -0.83 for cloud feedback, 2 for water vapor feedback, and 0.5 for ice feedback);**

**(C) high-end estimates of the feedback factors (i.e., the highest settings allowed by the sliders).**

**How does your calculated climate sensitivity range compare with the prevailing range of climate sensitivity estimates? In each case, does the mid-troposphere warm more, the same, or less than the surface? Is this pattern of warming consistent with the predictions by the state-of-the-art climate models? If not, what physics do you think might be missing in our one-layer model?**

**NOTE: If you enter values by hand into the boxes below the slider, make sure to click ENTER in each box for the changes to take the effect.**

**3. For the doubling of CO2 for the same three cases (A), (B), and (C) explored in Question 2, please answer the following questions.**

1. **What are the long wave and short wave forcing, and the total surface forcing (i.e., the sum of the two)?**
2. **Calculate the overall feedback factor*.* To do that, first take the ratio of the total surface forcing to the forcing due to the direct radiative impact of CO2 doubling alone, which simply equals the total forcing in the “no-feedback” case (A); then subtract one from this ratio.**
3. **What are the Earth’s albedo and the atmospheric emissivity? For cases (B) and (C) is there a change in the Earth’s albedo and atmospheric emissivity compared to the “no feedback” case (A)? Which feedbacks could be responsible for the observed changes in each case? [Recall that when the cloud factor is negative, it represents a negative short wave feedback due to formation of low clouds that reflect short wave radiation; when the cloud factor is positive, it represents positive long wave feedback due to formation of high clouds that trap long wave radiation].**